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I, KIM MARSHALL, MANAGER EXAMINATION SUPPORT AND SALES, hereby certify that the annexed is a true copy of the Provisional specification in connection with Application No. PP 5317 for a patent by NORMAN WILLIAM MACLEOD filed on 19 August 1998.

WITNESS my hand this Eighth
day of January 1999

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PROVISIONAL SPECIFICATION

Invention Title: MANUFACTURE OF FOOTWEAR

Applicant: NORMAN WILLIAM MACLEOD

The invention is described in the following statement:

MANUFACTURE OF FOOTWEAR

This invention relates to the manufacture of footwear.

More specifically this invention relates to the injection moulding of a sole onto a formed upper of an item of footwear, e.g. a shoe.

Many boots and shoes comprise an upper of flexible sheet material, e.g. imitation leather or real leather, having a base mounted on a sole moulded from a settable synthetic material, e.g. plastics or rubber.

The use of synthetic materials in the manufacture of soles for shoes is fairly well established. PVC, polyurethane, EVA and thermoplastic rubber have all been used to fulfil this purpose. These synthetic materials have appropriate functional properties and are aesthetically pleasing as well as being comfortable. Rubber is particularly sought after because of its durability, its resistance to hydrolysis and bacterial attack, and its thermal resistance.

Typically the upper is formed around a forming last in a first manufacturing step and then the sole is injection moulded onto the base of the upper in a second step. The last provides a template for the three-dimensional shape and size of the upper.

The first step involves mainly a shaping and stitching operation. As no heating is involved in this step, the last can be made of many types of materials, although plastic is particularly preferred because it is easy to form into the desired shape and is also inexpensive.

The second step of the process involves the injection moulding of the sole onto the base of the upper. Several synthetic materials have been known to be used for the sole. Rubber is seen as being particularly attractive and so-

called twin density rubber soles are particularly sought after because they provide a tough outer-sole and a resilient mid-sole. Expanded vulcanised rubber in the mid-sole contains cavities called cells, either open or closed, which give the rubber a desired level of resilience.

The moulding of rubber soles is an endothermic process and therefore it is necessary to supply generous amounts of heat to the mould. In this respect rubber is different to other materials, e.g. polyurethane, which cure at ambient temperature and in fact liberate heat on curing.

It is therefore necessary for the parts of a mould for a rubber sole to be heated to an appropriate temperature. As a result of this requirement of supplying heat to the mould, it has previously been necessary to manufacture rubber soled shoes in a discrete two step process. The first step comprised forming the upper on a last, typically a plastic last, and the second step comprised transferring the formed upper to an injection moulding assembly in which a rubber sole was injection moulded onto the upper.

However the process of transferring the formed upper from the last to the injection moulding assembly is very labour intensive. For example, it can easily add 25% to the cost of manufacturing a pair of shoes. A further disadvantage is that inaccuracies could occur when placing a lasted shoe on the injection moulding assembly causing pre-roughed and/or pre-cemented uppers to be incorrectly placed, potentially causing a problem with the bonding of the sole to the upper. It would therefore be highly desirable if a way of integrating the process of forming of the upper on the last and moulding the sole onto the

upper could be devised. Clearly this would streamline the whole process and cut down on the high labour costs.

According to an aspect of this invention there is provided a method of making an item of footwear, including:

forming an upper for an item of footwear on a last; and

injection moulding a rubber sole onto the formed upper while it is still mounted on the last.

Thus the upper remains mounted on the single last for the entire process including the moulding and vulcanisation of the rubber sole onto the upper.

As described above, the injection moulding of rubber is an endothermic process and it is therefore necessary to heat the last before and during the injection moulding.

Typically the step of injection moulding the sole includes heating the last to an appropriate temperature.

The last may be heated by electrical heating means, e.g. in the form of an electrical element, contained within the last. Typically the element would be embedded within the material from which the last is formed.

Alternatively the last may be heated by radiant heaters, e.g. spaced away from the last, prior to the moulding step, to generate the heat necessary to efficaciously mould the sole.

Naturally the moulding of the rubber comprises applying temperature and pressure to a rubber mix so as to vulcanise the rubber.

The moulding step may also comprise a two step moulding process for producing respectively a compact rubber outer-sole and an expanded rubber mid-sole.

This invention also extends to an item of footwear made in accordance with the above method.

According to another aspect of this invention there is provided apparatus for making an item of footwear including:

a last for forming a shoe upper; and

means for injection moulding a rubber sole onto the shoe upper while it is still positioned on the last on which it is formed which in turn includes means for heating the last.

Thus with this apparatus it is not necessary to take the shoe upper off the last on which it is formed before moulding the rubber sole onto the upper as the apparatus, and particularly the last, has means for supplying the necessary heat to the rubber so as to vulcanise the rubber.

Optionally the last may be made of metal, e.g. aluminium and have a side wall and a base. Aluminium is particularly suitable because it is light and thermally conductive. However it is expensive to machine.

Alternatively the last may be made of plastic. Optionally the plastic last may have one or more metal components, e.g. a thermally conductive metal plate extending across the base. Naturally such a metal plate will be operatively connected to a source of heat located within the last.

In one embodiment the last is made of plastic with a metal plate extending across the end of the last and a heating element which is operatively connected to the metal plate. Typically the metal plate is made of aluminium of 1/8 inch thickness and is connected in face-to-face contact with the heating element to provide direct heat conduction from the element to the metallic base plate.

Typically the injection moulding means includes an injector and a mould assembly comprising a plurality of mould parts.

Typically the mould parts comprise two side parts, a top part formed by the free end wall of the last, and a bottom part formed by a movable piston which acts to compress the rubber during the moulding process.

As the injection moulding and vulcanisation of rubber requires substantial heat, the mould assembly also includes means for heating the side parts and bottom part of the mould assembly. Typically such mould parts are heated by heating means, e.g. electrical elements, embedded in the mould parts, e.g. which are of metal.

Preferably the apparatus includes a dummy last in addition to said last for forming a compact outer-sole portion of a two density rubber sole.

Advantageously the apparatus includes a support movable relative to said injection moulding means and said last and dummy last are mounted on said support spaced apart from each other.

According to yet another aspect of this invention there is provided a last for making a shoe including:

a body member mimicking the shape and form of a shoe and defining a base corresponding to a sole of the shoe; and

means for heating the base of the body member, the heating means being contained within the member.

Typically the body member is made at least partially of plastic, e.g. polyethylene.

Advantageously the body member includes at least one metallic plate, e.g. of aluminium, extending across the base of the last.

Typically the heating means includes at least one electrical heating element contained within the body member. The heating element is desirably in contact with the metallic plate over a significant proportion of its surface area to provide effective and direct heat conduction to the metallic base plate.

Preferably the last further includes insulating means provided between the at least one heating element and portions of the body member to prevent excessive heat being transferred to the member. This is particularly desirable where portions of the body member are formed of a plastic such as polyethylene, since excessive heat transfer to the polyethylene could deform the body member.

Naturally the last also includes means for electrically connecting each heating element to an external power supply, e.g. mains supply. Preferably the electrical connecting means includes a bayonet-type coupling for connecting leads within the last to leads within the support on which the last is mounted.

Optionally the body member may comprise discrete heel and toe portions. Advantageously each of the heel and toe portions may have a heating element, a base plate portion, and an insulating means.

A method and apparatus for making a rubber soled shoe in accordance with the invention may manifest itself in a variety of forms. It will be convenient to hereinafter describe in detail several preferred embodiments of the invention with reference to the accompanying drawings. In the drawings:

Fig. 1 is a three-dimensional view of a rotary apparatus for making shoes in accordance with one embodiment of the invention;

Fig. 2 is a three-dimensional view of a last and last support for the apparatus of Fig. 1;

Fig. 3 is a schematic sectional side view of the last of Fig. 2.

Figs. 4a to 4c are schematic sectional front views of apparatus in accordance with another embodiment showing the injection moulding and compression moulding of a rubber sole onto a shoe; and

Fig. 5 shows an item of footwear with a leather upper and a compression moulded rubber sole.

Fig. 1 illustrates an apparatus 1 for manufacturing shoes having a leather upper and an injection moulded rubber sole. Fig. 5 illustrates a shoe 2 of the type which is typically made by the apparatus of Fig. 1. The shoe 2 comprises a leather upper 3 and a rubber sole 4 having a mid-sole 4a and an outsole 4b.

The apparatus 1 comprises broadly a turntable 5 having a plurality of lasts 6 mounted spaced apart around the circumference of the turntable 5. A number of stationary workstations 7 complementary to the number of lasts 6 are positioned radially outwardly adjacent the turntable 5. The lasts 6 are moved sequentially through each of the workstations 7 as the turntable 5 is rotated. The shoe 2 is progressively formed in steps as the last 6 is moved through the workstations 7. First the shoe upper 3 is formed on the last 6 and then the sole 4 is injection moulded onto the upper 3 before being cooled and removed.

The last 6 which has a carefully contoured side wall 8 and free base 9 provides a template for the shape and style of a particular size of shoe, and particularly the upper portion 3 thereof. The forming or manufacture of the upper 3 involves cutting, shaping and stitching of flexible material forming the upper which is typically real or imitation leather. The forming of the upper 3 takes place largely at room temperature and occurs at several workstations prior to presentation.

As the shoe upper 3 is formed on the last 6 at room temperature the last 6 can be made of any material. However for the purposes of moulding the rubber sole 4 onto the upper 3 it is desirable that the last 6 be made of thermally conductive material such as aluminium.

After the upper 3 is formed, the last 6 is moved around to a specific work station 10, namely the workstation at which the sole 4 is injection moulded onto the base 9 of the upper 3 formed around the last 3.

The apparatus 1 at this workstation 10 comprises broadly a mould assembly 15 defining the mould cavity for forming the shoe sole 4 and an injector 16 for injecting rubber mix into the cavity.

The structure and function of the injector 15 would be well known to persons skilled in the art and thus it will not be described in further detail here.

The mould assembly 15 defining the mould cavity for forming the rubber sole 4 comprises a plurality of mould parts namely two side mould parts and a bottom part 23. The top part of the mould is formed by the base 9 of the last 6. The bottom part 23 of the mould is operatively attached to a movable piston 24 which moves upwardly into engagement with the rubber mix during the moulding process compressing it and promoting vulcanisation. Typically the piston 24 is hydraulically driven although obviously other means could also be used.

As the rubber moulding process requires the input of substantial heat each of the mould parts are heated. Typically the parts are heated by electrical heating elements embedded (not shown) within the material of the mould parts. As the structure and functioning of the electrical heating elements are well known to persons skilled in the art, they will not be described in further detail here. It will readily be appreciated however that the mould parts may also be heated in other ways.

As the base 9 of the last 6 covers a large area of the mould for forming the sole 4, it is clear that this surface also has to be heated. Typically the last 6 is also heated by having an electrical element embedded within the material of

the last. Fig. 3 illustrates one example of a last for performing this function of heating the top surface of the mould or base of the upper.

The last 6 comprises two discrete parts, a heel portion 30 and a toe portion 31 which are attached end-to-end when the last 6 is fitted to the turntable assembly 5.

Turning first to the toe portion 31, an electrical heating element 32 is received within a recess defined in the portion 31. The element 32 is located adjacent the base 9 and a metal hot plate 33, e.g. of aluminium, extends across the base 9 and is fastened in position with screws S.

The plate 33 is thermally connected to the element 32 by face-to-face contact between the element 32 and the plate 33 over a substantial proportion of the surface area of the plate. This provides direct and effective heat conduction in a substantially uniform manner over the plate 33.

Insulating material 34 is provided on the side of the electrical element 32 opposite the base plate 33 to thermally shield the plastic part of the toe portion 31 above the base. When the base plate is heated to about 100°C - 120°C for the moulding process the heating elements themselves achieve temperatures even higher and the plastic parts of the last must be shielded to prevent their undesirable deformation.

The electrical heating element 32 is electrically connected to an electrical supply. Electrical leads 35 extend from terminals on the element 32 to the top surface 36 of the last 6. A releasable male-female bayonet type coupling 37

then enables the leads to be electrically connected to an external electrical supply (not shown).

The heel portion 30 similarly has an electrical heating element 38, a metal hot plate 39 (e.g. of aluminium) fastened by screws S, insulating material 34 and an associated pair of leads 40 and a bayonet coupling 41.

The last 6 will also include a thermostat (not shown) to monitor and regulate heating of the base plates 33, 39.

When the last 6 is mounted onto the rotating turntable 5 the electrical elements 32 and 38 are automatically coupled to an electrical supply which is used to heat the base 9 to an appropriate temperature.

The sole 4 is formed from a rubber mix material which is typically obtained from a specialist rubber supply company. The rubber mix comprises a basic polymer material which is irreversibly transformed from a plastic to an elastic state by a process of vulcanisation. The vulcanisation of the basic polymer material essentially involves three-dimensional cross linking of the polymer molecules. Vulcanisation is accomplished under specific conditions of elevated temperature and pressure. The rubber mix also includes basic polymer and additives including fillers and protective agents.

In use an appropriate quantity of rubber mix is injected into the mould cavity. In the illustrated embodiment the injector 16 actually projects into the cavity and is then withdrawn. It will be appreciated however that other injector arrangements can also be used. Heat is then applied to the rubber mix and it is compressed by moving the piston upwardly into compressing engagement with

the mix. This then effects vulcanisation of the rubber which converts it into an elastic state. This sequence of steps is illustrated particularly clearly in Figs. 4a to 4c. It is to be understood however that Fig. 4 indicates the manufacture of a single low density sole as distinct from the two density sole described below.

One particularly useful property of rubber is that it can be used to make a two-density rubber sole, e.g. an expanded rubber mid-sole and a thin layer of compact rubber which forms the outer-sole moulding in two discrete steps. The first step comprises forming the compact rubber outer-sole and the second step comprises forming the expanded rubber mid-sole.

This process will now be described with reference to Fig. 2. Associated with each last 6 for forming a shoe upper 3 and mid-sole is a dummy last 50 for forming the compact rubber outer-sole. The last 6 and dummy last 50 are mounted on a common support 51 which is rotatable on the turntable 5. The support 51 is rotatable between a first position in which the dummy last 50 extends into the mould cavity and the last 6 is spaced away therefrom and directed upwardly, and a second position in which the last 6 projects into the injection moulding cavity and the dummy last 50 points upwardly.

In the first step the outer-sole is moulded with the dummy last 50 in position in the mould cavity and in the second step the mid-sole is formed with the actual last 6 and shoe upper 3 in the mould cavity. It is the second step therefore which actually physically attaches the sole 4 to the fabric base of the upper 3. Fig. 2 shows the last and shoe in the upwardly facing inoperative position.

After the entire sole has been vulcanised, the last 6 with the completed shoe is removed from the machine, and replaced with a lasted shoe which is ready to have a sole attached. The complete shoe is then moved to further work stations where the shoe is cooled and then detached from the last 6. The last 6 can then be moved on to further work stations where the entire process can be repeated.

An advantage of the method described above is that the upper does not need to be transferred from a last for forming the upper to a vulcanising last during the process. Accordingly the manufacturing process is substantially cheaper and the end product is arguably of better quality. As the footwear industry is very competitive the lower production cost is very significant.

Finally it is to be understood that various other modifications and/or alternations may be made to the parts and components herein described without departing from the spirit of the present invention as outlined herein.

DATED: 19 August, 1998
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Attorneys for:
NORMAN WILLIAM MACLEOD

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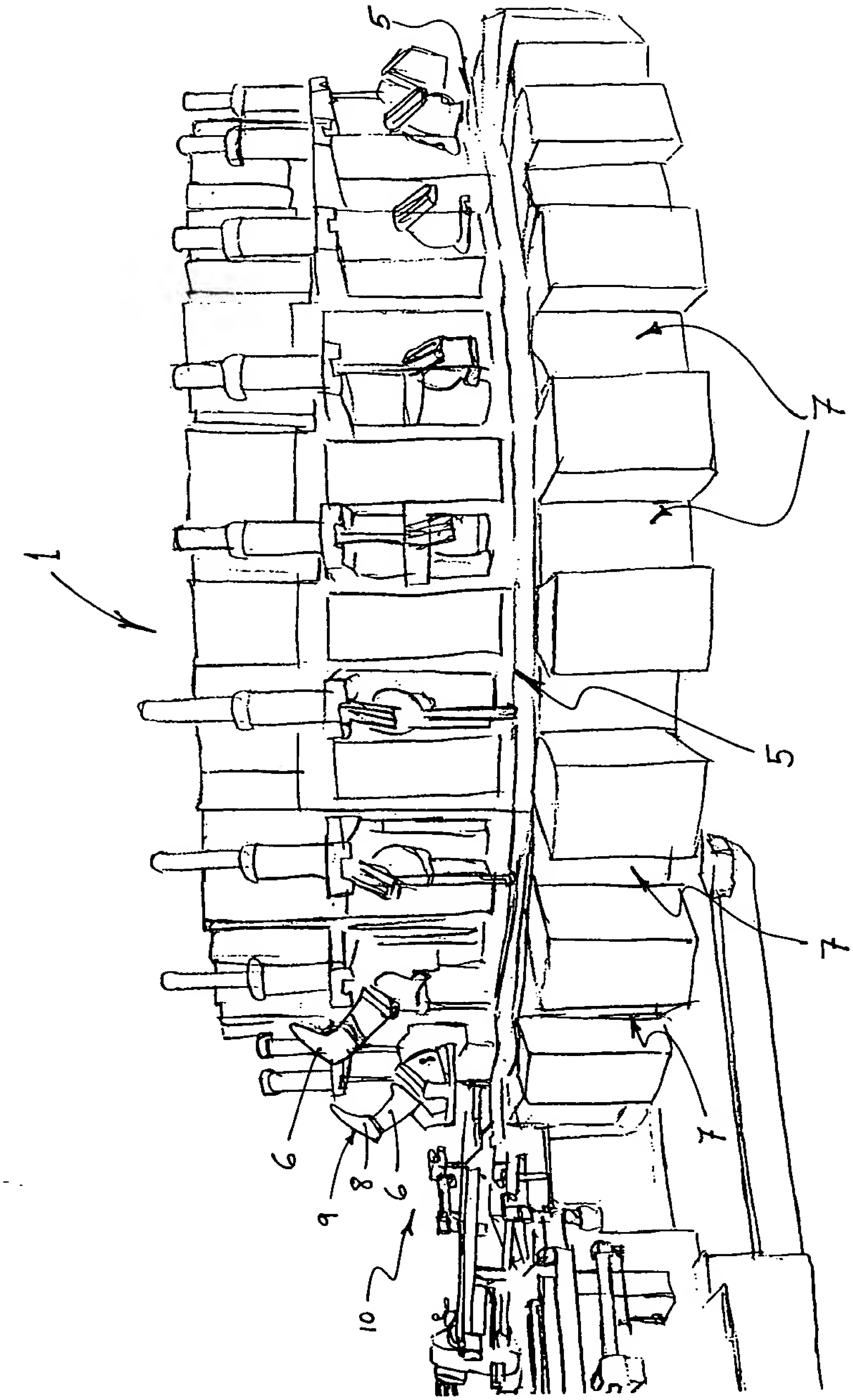

FIG. 1

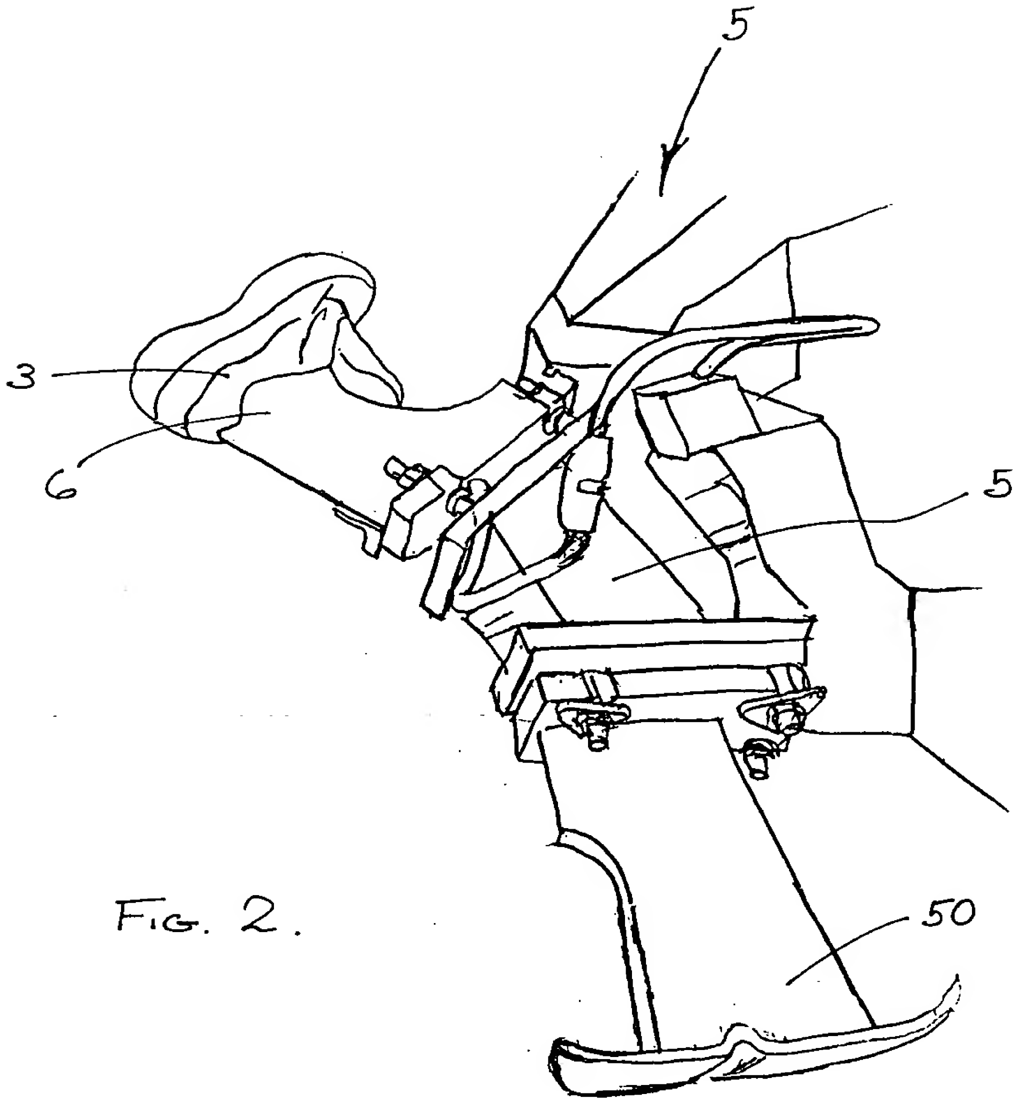

Fig. 2.

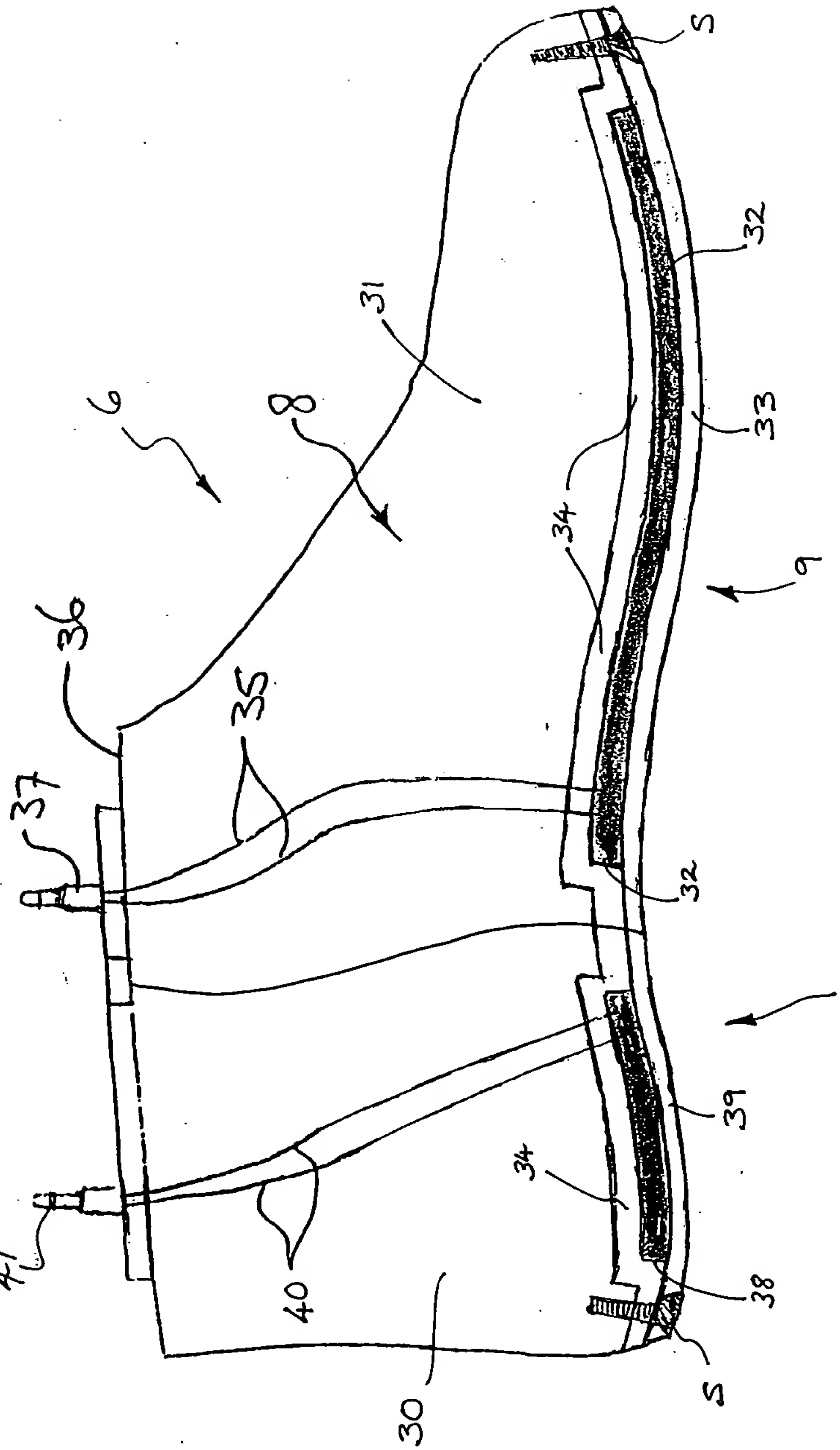

FIG.3.

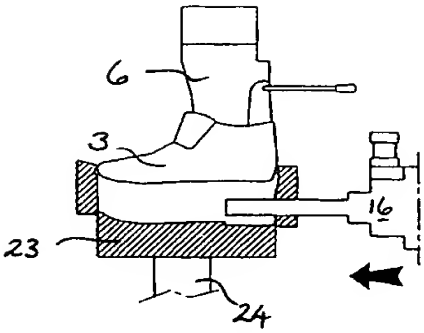

FIG. 4a.

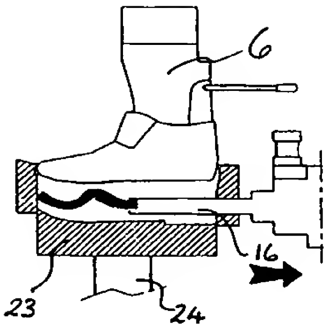

FIG. 4b.

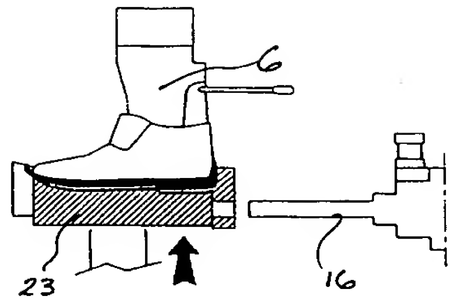

FIG. 4c.

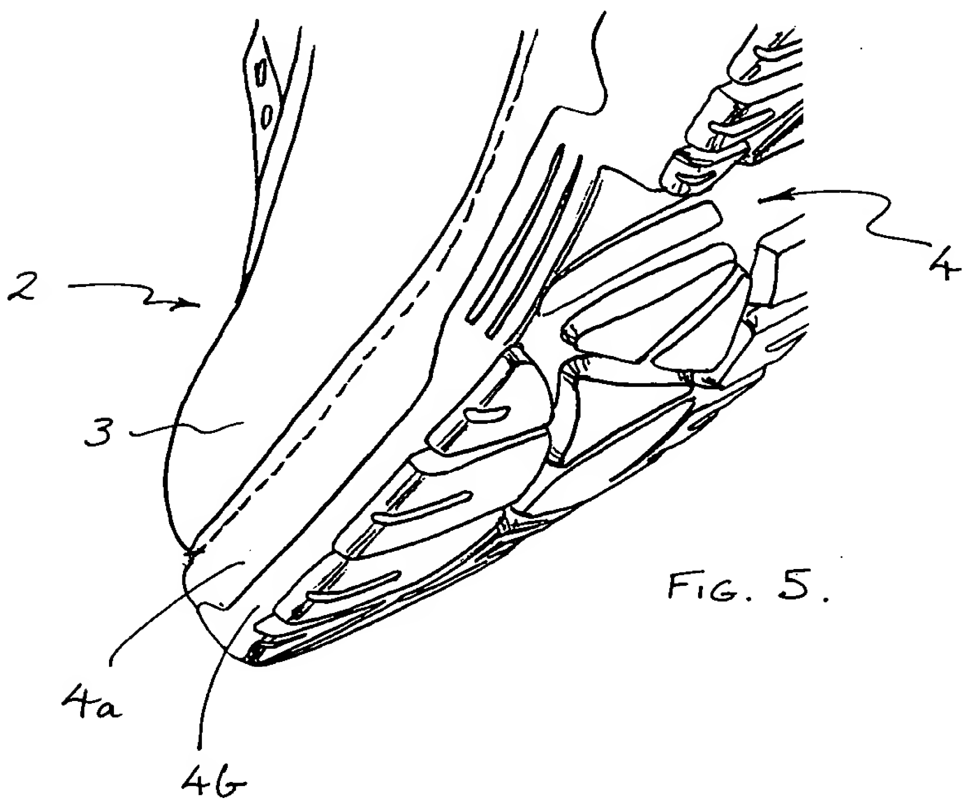

FIG. 5.